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THE AMERICAN METEOROLOGICAL JOURNAL.

A MONTHLY REVIEW OF METEOROLOGY.

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THE AMERICAN

METEOROLOGICAL JOURNAL.

VOL. XII. BOSTON, MASS., NOVEMBER, 1895. No. 7.

EDITORIAL NOTE.

IT is with great pleasure that we publish in this number of the JOURNAL Prof. Willis L. Moore's address on the "Relations of the Weather Bureau to the Science and Industry of the Country," delivered before the American Association for the Advancement of Science, at Springfield, Mass., on Aug. 30. We are sure that the paper will be read with interest and with satisfaction by all who believe in the scientific work of the Weather Bureau, many of whom were afraid that the change of its Chief meant that the Bureau's activities in this direction would cease. Prof. Moore's address contains the welcome assurance that there is no cause for such a fear.

RELATIONS OF THE WEATHER BUREAU TO THE SCIENCE AND INDUSTRY OF THE COUNTRY.*

WILLIS L. MOORE, CHIEF OF THE WEATHER BUREAU.

Mr. President and Members of the American Association for the Advancement of Science:

IT is a matter of much pleasure to me that I am allowed the privilege of speaking at a joint session of this Association — representing as it does within the confines of its admirable organization the scientific thought of our country. This is the Mecca towards which annually journey all those who wish each to contribute his mite to the sum of human knowledge; each

* Read before the American Association for the Advancement of Science, at Springfield, Mass., Aug. 30, 1895, and published simultaneously by Science and by this JOURNAL.

inspired with an ambition to add even one flickering ray to the great luminous orb which to-day is shedding the benign light of wisdom even unto the uttermost recesses of the earth, subduing the barbarous instincts of man and warming and invigorating into life the better impulses of his nature. Thus is civilization advanced, and thus is humanity elevated to higher and higher planes of existence.

I hope to be a worker in the ranks of this great army, and as the science of meteorology can hardly be said to have passed beyond the embryonic state, I feel that the realms of investigation are boundless, and that the opportunities are correspondingly great.

As the Chief of the greatest meteorological system in the world, and with the power to control, under the direction of the Honorable Secretary of Agriculture, not only its executive functions, but the lines of future scientific investigation, I fully realize the great responsibility that rests upon me, and that, at the bar of public and scientific opinion, I shall, in the years to come, justly be held to a strict accountability for my stewardship.

Before considering the line of investigation which consistently can be prosecuted by the Weather Bureau, it will be well to note the law which prescribes the duties of the chief.

By an Act of Congress approved Oct. 1, 1890, Sect. 3, it is provided,

"That the Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, on and after July 1, 1891, shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation, the gauging and reporting of rivers, the maintenance and operation of sea coast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rainfall conditions for the cotton interests, the display of frost and cold wave signals, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties."*

It will be seen that the main object for the existence and continuation of this Bureau is to give warning of the approach

* Statutes at Large. Fifty-First Congress. Page 653.

of storms, and therefore that the proper line of investigation should be for the purpose of determining the true philosophy of storms. The goal to be striven for is the improvement of weather forecasts, and surely one of the prerequisites to determine coming events is a thorough knowledge of existing conditions.

To those who have read every important treatise on meteor ology, and who have studied every text-book on the subject, it is painfully patent that we are extremely ignorant of the mechanism of storms; of the operations of those vast and subtle forces in free air which give inception to the storm, and which supply the energy necessary to accelerate cyclonic action when formed, or to disperse the same when once fully in operation. We know that great atmospheric swirls in the shape of high and low pressure areas alternately drift across the country at intervals of two or three days; that the atmosphere flows spirally into the cyclonic, or low pressure, system, and outward from the anticyclonic, or high pressure, system; that the in-drawn east and south winds on the front of the storm are warm, and that the inwardly-flowing north and west winds are cold.

The theories of Redfield, Espy, Loomis, Ferrel and others teach that our great storms are composed of immense masses of air gyrating about a vertical or nearly vertical axis, drifting eastward and at the same time drawing warm easterly currents in at the front and cold westerly currents into the rear: that the commingling of these two as they rise to greater and greater elevations, near the region of the cyclonic centre, throws down volumes of rain or snow; that as precipitation occurs with the ascending currents the heat of condensation energizes the cyclonic circulation; that the air at the centre of the storm is relatively warm, is rarefied by centrifugal force, and by reason of less density, rises to a great elevation, and in the upper regions of the atmosphere flows away laterally to assist in building up the high pressure areas on either side.

The high and low pressure areas are supposed to be carried eastward by the general easterly drift of the atmosphere in the middle latitudes, somewhat as eddies are carried along by water in a running stream.

But unfortunately for the complete accuracy of these theories, the forecaster often finds heavy downpours of rain without any

cyclonic circulation and no convectional system in operation; again, over immense areas of our country, especially in the Rocky Mountain region, for many months in the year, condensation occurs not at all in the warmer easterly currents flowing into the storm centre, but almost exclusively in the south and west quarters of the storm area, where the cold north and west winds are flowing in.

Again, many investigators to-day have good reason to doubt that the centre of the storm is warm to any great elevation, or that cyclonic circulation obtains to the top of the air.

In outlining, in a rough and general way, the line of investigation which, in my judgment, promises to give the most prolific results, not only to the cause of meteorological science, but to the making of more accurate forecasts for the benefit of agriculture and commerce, I will say that we have been for years taking our measurements at the bottom of this great ocean of air, while the forces which cause the formation of storms, and which influence their intensity and direction of motion operate at great elevations, or are extraneous to our earth. It therefore seems imperative that systematic exploration should be made of the upper air. Balloon ascensions should be made in the several quadrants of a cyclonic storm, and also at the centre thereof, especially when rain is falling and the barometric gradient is steep. It is especially important to know the level at which condensation ceases, the depth of the cloud stratum, the temperature gradient, the air pressure and humidity, to a height of four or five miles. Skilled aeronauts with complete and accurate instruments should be placed in the region of severest action at the season of the year when storms are most frequent. They should be held in readiness until the approach of storms typical of cyclonic action, and then from the central office, where the movement of the storm is being carefully watched on the daily synoptic chart, they should be given telegraphic orders to ascend, and their ascensions should be so timed as to secure accurate readings at great elevations throughout the several quarters of the storm. It is believed that information thus secured will establish something like an approach to the true philosophy of storms in contradistinction to the very imperfect theories which too often are hastily approved as demonstrated principles.

Practically all of the theory of storms has been written by men not daily engaged in watching their inception and progression with the help of the weather map. Instead of erecting a cumbersome superstructure upon the sand, let us endeavor to lay a corner stone upon which to erect something exact enough to be called a science.

In winter the great high pressure areas which constitute our cold waves should receive the same thorough exploration. Readings at Pike's Peak or Mt. Rainier might be useful in this investigation, but they are too far removed from the general track of storms and cold waves to furnish the full information desired.

Upper air exploration may be accomplished by a train of kites carrying automatic instruments, by captive kite-balloons, which may be forced nearer and nearer the zenith with increasing wind velocity, or by the ascension of trained observers in free balloons. We must strive for the perfection of appliances and instruments which will, at no distant day, enable us to present to the forecaster the charted synchronous meteorological conditions prevailing at high levels, and covering a great area. Mr. McAdie, at Washington, has secured recently some good records with kites at 1,000 to 2,000 feet elevation.

Systematic exploration of the upper air, with a continuation of the studies begun by Professor Bigelow of terrestrial magnetic forces as induced by the solar magnetic field, will be the line of investigation prosecuted during the next two years, and from which it is hoped that results satisfactory to the practical as well as the theoretical man may be obtained. The Honorable Secretary of Agriculture is in thorough sympathy with all lines of research which can be legally carried on under the Act of Congress constituting the Weather Bureau, and which promise to give results useful to the people.

Harmonious co-operation between the practical worker and the scientific investigator is essential to success. Too often they have found themselves picking out diverging paths. In the future they will work on parallel and converging lines, and not far removed from each other, and the result, I am confident, will be beneficial to all. In a great system like ours each worker must be justly recognized for the merit that is in him, whether he be a skilled scientist or an able executive

officer, and he should be given his proper place as an integral part of the great whole which constitutes the efficient Bureau.

A brief retrospect of the forecast may not be without compensating results in our efforts at future improvements. Forecasts were begun in the United States about twenty-five years ago, and have, during the past decade, become of such benefit to the many and diversified interests of the country that with one accord the people now acknowledge their value and applaud all efforts to improve and extend their usefulness. Fifty million dollars is a low estimate of the value of property placed in jeopardy by one West Indian hurricane sweeping up our Atlantic Coast.

Predictions were first called "probabilities," and were made for districts, each comprising several States, and included a prediction as to the probable change in barometer. Later the prediction as to barometer was omitted. Forecasting by districts was soon shown not to be specific enough as to boundary, and the designations applied were not well understood by the people; hence forecasting by States was adopted. Forecasts were made only at the Central Office at Washington, and the local observers were allowed to disseminate no other, nor to give public expression to any opinion of their own which might be construed into a forecast. Considering the very limited training of the observers and the lack of all charted meteorological conditions for their study and enlightenment, the wisdom of that regulation could hardly be questioned.

With the transfer of the Weather Bureau to the Department of Agriculture came the inauguration of far more liberal and progressive ideas. The office of Local Forecast Official was created for such observers as had shown special fitness for forecast work, and they were assigned to duty at the more important agricultural, commercial, and maritime centres, with instructions to carefully study the local climatology of their sections, so that products which were indigenous to limited areas, or interests which were of special importance to particular sections, might have such application of the weather forecasts as the intimate personal attentions of a competent local official could give.

The changes enumerated have been carefully tested and found to be beneficent in purpose and worthy of continued and per-

manent application. Thus has the forecasting system of to-day slowly developed during the past twenty-five years. Is it not the essential feature of the Weather Bureau? Is it not the nucleus around which all departments of thought and study must rotate and become auxiliary, if the original intent of Congress, made manifest by the establishment of a national storm-warning system, is to be carried forward to as successful operation as the present knowledge of the physics of the air will permit? It is to be hoped that discoveries may be made relative to the controlling and modifying forces of storms which shall raise the standard of forecasting accuracy attained by our most expert officials, who have had all the benefits to be derived from many years of patient and intelligent observation of storms from the time of their inception in, or entrance within, our daily observed and charted territory, until they have been dissipated or have passed eastward beyond our range of vision.

It may be well to consider what class of forecasts can be most successfully made by our more or less empirical methods, the object being to extend the work along such lines of activity as promise the most beneficent results. As to this proposition, it is doubtless conceded by all that when pronounced high and low pressure areas dominate the weather conditions and the changes in wind, temperature, and weather are characterized by such force and degree as to render them destructive to lives and property, a forecaster of average ability and well-balanced judgment is able to make nearly or quite as accurate a forecast as when the air pressure is quite uniformly distributed and all changes of weather are so slight as to be of no importance.

If, then, a destructive frost or cold wave can be predicted as easily as a change of a few degrees in temperature, and if the coming of high winds and gales are as easily foretold as that of a gentle zephyr, it is evident which class of forecasts should receive the greater attention. The public care comparatively little for predictions of moderate changes, and but little credit attaches to the Bureau when such forecasts are verified, but when great heat, cold waves, or violent winds are on the program, a vital interest in the subject is felt, and the accurate forecasting of such conditions is the gauge by which the public measures the usefulness of the Bureau.

Horticulturists and the growers of tobacco and cranberries

realize the vast benefit to be derived from accurate frost predictions, and I will give a brief statement of what I believe to be original ideas introduced into the making of frost forecasts while in charge of the Wisconsin State Weather Service, a State including within its domain the largest area of cranberry marshes in the world, and also including an extensive area devoted to the cultivation of tobacco. Heretofore I believe that only the air conditions have been taken into consideration in the making of frost forecasts, — such as pressure, temperature, relative humidity, cloudiness, and wind velocity. As a result of my investigations, systematically prosecuted for three years, I found that the conditions of the soil were equally as important as those of the air.

When the high-pressure area is moving in from the West, clear and colder weather anticipated, with the probability that the early morning temperature will permit the formation of frost, the most important elements to be considered in determining whether or not frost will occur, injurious to growing crops, are as follows: —

First. Has rain recently fallen, and what is the condition of the soil relative to the amount of moisture contained?

Second. What are the natural properties of the soil relative to the slow or rapid loss of heat by radiation?

Third. To what degree of heat has vegetation been subjected during the period immediately previous?

The early fall frost, injurious to tender crops, is the one which occurs with the town or telegraphic minimum temperature ranging from 40° to 50°, because, when the early morning temperature in the town falls much lower than 40° F., it is usually so late in the season that all crops are gathered, or if not gathered, they have been destroyed ere this condition arrives. At the time, then, that frost warnings are of most benefit we have to deal with the air at temperatures considerably above the freezing point, and to recall that a deposition of frost requires that the temperature of the top soil, or that of vegetation, be reduced to the freezing point. This, of course, is accomplished by conduction and radiation of heat, which takes place more rapidly from the soil and vegetation than it does from the lower stratum of air to the higher.

Anything that will seriously interfere with a rapid loss of heat

after nightfall will tend to prevent the formation of frost. Moisture does this, and if the soil be well charged it partakes greatly of the stable temperature condition of water, and cools but little, if any, below the temperature of the superincumbent air, and no frost will occur even though all other favorable conditions, *e. g.*, clearness, gentle winds, and cool air, obtain. Even a small amount of moisture, say one half inch of rainfall, will give ample protection if well distributed and precipitated within the 24 hours previous. But when severe drought conditions are prevalent, injurious frosts may occur when the telegraphic temperatures do not show a reading within ten degrees as low as in the first case.

I believe that when estimating the probability or severity of frost, sufficient weight has not been given to the dryness or wetness of the soil and the resultant dissipation or conservation of heat energy, and I call special attention to the point as one of the means for improving the forecast. I have in mind two typical cases. In the first, a high pressure area attended by clear and cool weather drifted from the westward until it covered the State. No rain had fallen with the passage of the low pressure area immediately preceding it; hence the ground was in excellent condition for the rapid loss of heat during the night, and a consequent lowering of the temperature of vegetation to the freezing point. Considerable damage was done to cranberries in unflooded marshes. In the second case, a high pressure area of slightly greater weight and slightly lower temperature covered the region about ten days later, but it was preceded within a few hours by a light but well-distributed fall of rain, averaging about one half an inch, and no frost occurred. In both cases the wind was gentle from the northwest, and the nights were clear. With slightly lower air temperature and higher barometer in the second condition, heavier frost would have occurred than in the preceding case, had it not been for the thinly-spread moisture of the timely rain conserving heat at the surface of the earth.

Might not this principle be carried further in the improvement of the forecast? Assuming that the caloric energy of the sun is a constant factor, the earth receives each year the same amount or intensity of heat, and as the atmosphere is warmed mainly by contact with or radiation from the earth, seasonal

variations of temperature which are marked departures from the normal might result from abnormal terrestrial surface conditions with respect to the conservation of this constant solar energy over large continental areas. Here the excessive or deficient rainfull during the preceding seasons should receive careful consideration. The subject is one that requires deeper and more detailed investigation than the length of this paper will permit.

I find that the minimum temperatures in cranberry marshes during abnormally dry seasons often fall 15° below the temperatures telegraphed from the cities and towns within a few miles of the marshes. This is due to the fact that when the loose spongy peat, of which the marsh is composed to the depth of several feet, has dried out, the radiation of heat during the night is very rapid and is not counterbalanced by conduction and convection from the marsh. The temperature therefore in cranberry marshes is at all times much lower than that which obtains in marshes composed of heavy black muck, where it preserves a more stable condition, such as is common to air resting over a considerable body of water. A dry cranberry marsh does not therefore enjoy that immunity from frost which wet marshes and watery lands get the benefit of. But, when the ditches are flooded from the reserve water supply on receipt of a frost warning, the water quickly percolates through the peat composing the marsh, and the rapid loss of heat by radiation is checked and the frost diverted.

The degree of heat to which vegetation has been subjected immediately before the frost condition, and the temperature under which it has made its growth, will in a great measure determine the extent of damage to ensue.

By carefully considering the principles herein enunciated, I will say that in 1894, twelve out of fourteen official forecasts of frost were fully verified, — a much greater percentage of accuracy than has ever been attained by simply considering air conditions alone.

THE METEOROLOGICAL OBSERVATORY ON MONTE CIMONE, ITALY.

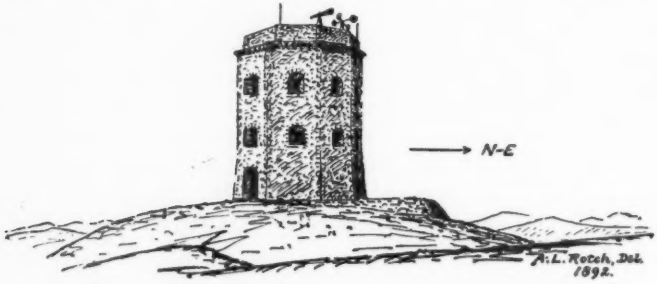
A. LAWRENCE ROTCH.

History and Cost. This is the only summit station in Italy, the observatories on Vesuvius and Etna being both situated on the flanks of these volcanoes. The conception of an observatory on Monte Cimone by M. P. Tacchini, now director of the Central Meteorological Office at Rome, dates back more than fifteen years, of which twelve were occupied in its construction. The cost, which amounted to $14,000, was defrayed by grants from the Minister of Agriculture and by private subscriptions.

Location and Construction. Monte Cimone is the culminating point of the Northern Apennines, attaining a height above the sea of 7,100 feet, and rising from the Pass of Abetone, above the Baths of Lucca, into two peaks, on the northern and higher of which is the observatory. This is an octagonal tower, 26 feet in exterior diameter and 46 feet high, built of limestone quarried on the summit, with walls 3 feet thick, cemented outside. A detached series of arches supports the vaulted ceilings of each story and forms central chambers about 12 feet in diameter, and between the wall and the arches are rooms and alcoves in which the stairways are placed. There are three stories and a flat roof, on which the wind instruments and rain gauge are exposed, and in a cellar sunk in the rock are storerooms and a cistern holding 140 cubic feet of water, obtained from the roof. The entrance is on the south side of the ground floor; the second story has a living-room in the centre with bedrooms, kitchen, etc., around it, while the third story contains the registering portions of the meteorological instruments. The small windows, flaring outwards, are provided with wooden shutters, and wood-burning stoves are used for heating and cooking. Protection from lightning is sought by four rods, rising above the parapet on the roof, which an encircling wire cable connects with two cables leading to the ground.

The sketch of the building is as it appeared from the south-east in 1892.

Meteorological Instruments. Besides the ordinary instruments to be read periodically, there are the following self-recording ones: A barograph and thermograph were constructed specially by MM. Richard Brothers, of Paris, to operate three months without attention, the clock, driven by a weight, unrolling paper at the rate of 1.5 inches per day. The Bourdon tube, constituting the thermometer, is about three feet long and is exposed with a standard thermometer in a north window, enclosed by stone slabs and shut off from the inner room by



THE METEOROLOGICAL OBSERVATORY ON MONTE CIMONE (ITALY), Altitude 7,100 Feet.

double doors, while the capillary tube transmitting the indications to the register has a device for neutralizing the temperature acting upon it. The thermometer exposure seems to be defective, as, owing to the surrounding masonry, sudden changes of temperature are moderated.

The register for the anemometer and wind vane is that made by Brassart, of Rome, for the Central Meteorological Office. A band of paper is drawn by clock-work between rollers and, on the completion of each kilometer of wind as measured by the Robinson cups, a hammer is dropped whereby one or two of four needles, representing the cardinal wind direction as indicated by the vane, are imprinted on the paper. The needles and hammer are actuated by magnets connected with electric contacts on the spindles of the vane and anemometer, respectively, which are exposed about five feet above the southeastern parapet of the tower.

The receiver of the pluviograph is of wood, in the form of a truncated cone about four feet high with an opening one foot in diameter slightly above the southern parapet. A stove pipe traverses the receiver in order to melt snow, and the water passes down to the register. This arrangement appears bad, and it is probable that a considerable portion of the precipitation is lost from the sweeping of the wind over the gauge.

Observations and Management. Six eye observations were made daily in the summer of 1892, under the direction of M. P. Videmari, who has for several years maintained a base station, provided also with self-registering instruments, at Sestola, 4.5 miles east of, and 3,500 feet below, the mountain top. Both stations are dependent upon the Central Meteorological Office at Rome, with which there is telegraphic communication.

PHYSIOLOGICAL EFFECTS OF HIGH ALTITUDES.

A. LAWRENCE ROTCH.

IN these days of exploration, when efforts are being made to attain great altitudes on mountains and in balloons, the effect of the rarefaction of the air on the human system is of importance, although, as yet, but imperfectly understood.

It was long ago demonstrated by aeronauts that respiration is so hindered as to produce asphyxia and death, if the stay is prolonged at heights of about thirty thousand feet. But the symptoms of the so-called mountain sickness (the *soroche* of the Andes), which are shortness of breath, nausea, violent pains in the head and back, etc., commence generally above twelve thousand feet, although dependent upon the individual and on circumstances. The rapidity of balloon ascents is more than offset by the short time the aeronaut remains at high altitudes, as compared with the mountain climber, who also becomes exhausted by the muscular effort put forth, from which it follows that in his case the sickness is much more marked, so that formerly, indeed, it was supposed in some way to be connected with the mountain itself, and hence its name.

The rise of balloons is often very rapid. For instance, Glaisher ascended five and one half miles, and thereby reduced the atmospheric pressure to one third its normal value, in fifty

minutes; while Hazen in this country has risen a mile in five minutes. On the other hand, perhaps the fastest high ascent possible on earth is accomplished on a railroad in Peru, where nine hours are required to rise from sea level to two and one half miles above it, and although the atmospheric pressure is diminished less than one half and no muscular exertion is necessary, yet considerable discomfort is generally experienced by travellers.

Paul Bert, the distinguished French physiologist, twenty years ago investigated in the laboratory the effect of pressure on animal life, and concludes (in *La Pression Barométrique*) that decrease of pressure only affects it by diminishing the tension of oxygen in the air, which the animal breathes, and in his blood and threatening asphyxiation. He states that the injurious effects of decreased pressure can be overcome by breathing air sufficiently rich in oxygen to maintain the normal tension of this gas. M. Bert demonstrated his theory in a pneumatic cabinet, but he ignored the factor of time and did not explain acclimatization.

Quite recently Dr. Egli-Sinclair's experiments on Mont Blanc (see J. Vallot's *Annales de l'Observatoire au Mont Blanc*, Vol. I.) have tended to confirm Bert's theory. The former supposed that, by reason of the diminution of the tension of oxygen, the blood is less rich on mountains than in the valleys; that it is the red coloring of the blood, or hemoglobin, which absorbs oxygen from the air, and that the number of these corpuscles diminishes with altitude. Dr. Egli-Sinclair thinks that the number of red corpuscles does not change under constant pressure, but that the slow recovery noted under these conditions is due to the gradual oxygenation arising from decreased consumption.

The experience of the writer during three visits of from one to three days' duration at M. Vallot's cabin (altitude 14,300 feet), where Dr. Egli-Sinclair's observations were made, seem to corroborate them. The sickness did not manifest itself at first, but after several hours' rest; it was more severe at night and when reclining, perhaps on account of the closeness of the room and the increased difficulty of respiration, and was alleviated by inhaling oxygen and by doses of phenacetine; on the second day the acute symptoms disappeared, though respiration re-

mained difficult. A sojourn of sixteen hours in the Andes, at a height of 16,600 feet, reached on a mule, occasioned some curious sensations which are described in this JOURNAL, Vol. X., page 286.

Edward Whymper, the famous English climber, who specially studied the subject of mountain sickness (in his *Travels Amongst the Great Andes of the Equator*), believes that the various affections classed under this term are due, (1) to the lessening of the value of the air that can be inspired in any given time, and (2) to the expansion of the air or gas within the body, which presses upon the internal organs. He considers the first-named effects to be permanent while the cause exists, but that the latter may be temporary and pass away when equilibrium has been restored between the internal and external pressure, or that they may be fatal under a very large and rapid reduction of pressure. Whymper concludes that "the effect of respiration alone will, in every country and at all times, impose limitations upon the range of man; and those persons in the future who, either in pursuit of knowledge or in quest of fame, may strive to reach the loftiest summits on earth, will find themselves confronted by augmenting difficulties which they will have to meet with constantly diminishing powers."

CURRENT NOTES.

Climate and Health. — The following paragraphs are taken from an article on "Climate and Health," by Dr. Charles Fayette Taylor, in the "Popular Science Monthly" for July, 1895: —

"In the divisions of land and water, the situations of the continents, the seas and the islands in the seas; the mountain ranges and the rivers which have their sources in them; the elevations and depressions of the more even surfaces, together with procession of the seasons and the earth's diurnal revolutions, we have some of the conditions for a great variety of climates. Proceeding from the equator toward the poles or moving along the surface of the earth in any direction, man, who seems to be the toughest animal on the face of the earth, can so adjust himself to varying climatic conditions as to exist in fairly good health almost anywhere, from the steaming equatorial jungles to the regions of perpetual ice and snow, as well as in intermediate locations where often heat and cold vary from one extreme to the other in rapid succession. And yet men live and thrive in nearly all lands and under the most diverse conditions, and with intelligent self-adjustment to their environment they may live well and live out their allotted times as a general rule. While the human race is exceedingly flexible, and can adapt itself rapidly to very diverse conditions, such adaptations, be they rapid or relatively slow, are not accomplished without an expenditure of energy to correspond with the functional modifications thus brought about. We call the process acclimatization, and the person, after subjection to the process, we say is acclimatized. That is to say, the functional activities of such a person have become adjusted to his environment; his functions have learned to harmonize with the temperature, food, humidity, and other influences affecting him. The effect on the individual varies according to his susceptibility and the degree and intensity of the factors acting on him. In some cases sluggish functional activities are energized with atonic effect; but when that is the case it does not follow that the new climate is necessarily intrinsically better than the one from which he came. In other cases the effect of climate change often proves atonic, depressing, and injurious; but a bad effect on an individual does not prove that the climate is necessarily worse than the one to which he was formerly accustomed. It may happen that influences, good in themselves, may be injudiciously employed, as, if a person requiring a cooler climate, such as that of the coast of Maine, for instance, should try Labrador, and it should be more than he could bear; or, if one needed a milder climate and should find Para too depressing. Even the relatively slight difference between the European and American sides of the Atlantic often proves serious to the immigrant during the process of acclimatization, and many succumb, though

it is probably true that the majority of immigrants find themselves invigorated in their new conditions of life on this side of the Atlantic.

"My object is to call your attention strongly to the well-known fact that change of climate and its attendant circumstances, even when not of any extreme character or degree, does produce an impression more or less profound on the vital processes, and that the nature, degree, and general therapeutic or pathological character of these influences should be more carefully studied than they have thus far been studied, so that when consulted by our patients we may have some definite advice to give in regard to locations best suited to the inquirer's special needs; or, if we cannot do so much, we ought, at least, to be able to give our patients some very positive ideas as to the kind of climate to seek, and especially what to avoid. For instance, California is seven hundred and seventy miles long. It embraces, according to Dr. Remondino, at least seven climates, distinctly different from each other, and all very different from the climatic conditions existing on this side of our continent. What is the sense in telling a patient with a hole at the top of his lung to 'go to California,' without instructing him in regard to the location to which he should go, or at least what kind of climate he should look for? Without some specific information such a patient is likely to drop into a place better calculated to shorten than to prolong his days. To be sure, all the climates of California are characterized by a dryness exceeding what is known in the East, and this fact gives some relative advantages. But unquestionably the air may be too dry in certain localities for certain cases. Is it not too much to expect a patient to find out what the doctor who sends him away from home and friends himself does not know? Besides, there are many constituent elements which enter in to make up what we call 'climate.' The first of these to be mentioned is usually the thermometrical readings, and the 'mean' temperature is generally quoted as proof positive of superiority when it varies a few degrees one way or the other from that of another locality with which it is compared. Now, the truth is, that to know the mean temperature of a place, and to know only that, is to know very little about its climate. The physiological effects of a climate must necessarily include the degree of humidity, the force and direction of the prevailing winds, the sunshine and cloudiness; the fogs and their characteristics — whether thin or dense, high or low, whether coming down from the mountains or rolling in from the sea; besides other unmeasurable influences not seen though felt: all these and more must be appreciated in order to give the single factor of relative temperature any positive quality whatever.

"For instance, the mean temperature of the seven hundred and seventy miles along and near the coast of California varies but a few degrees, though the extremes vary much. But the physiological effects of the climates of different areas vary greatly. There are stiff northwest winds from off the Pacific, carrying a thin, swift-moving fog that chills an invalid to the bone, during July and August, in San Francisco. To correspond to the sensations, the thermometer there lies like a cheap watch, and should be twenty degrees lower. A few miles back from the coast, with less wind and little fog, one's bodily comfort is perfect, and life is worth living, though the

unlucky thermometer persists in recording nearly the same average as when you had been shivering on the coast. I conclude that the physiological influence of a given temperature below a certain degree, say below sixty, with a wind ten or fifteen miles an hour, is equal to at least ten or fifteen degrees lower in scale. On the other hand, a thermometrical showing of 90° and over is not uncomfortable if there is a gentle breeze and little humidity, but with a strong wind becomes a sirocco, when prostrations are numerous, and, if long continued, many aged and feeble die under its influence. In one of the interior valleys of California I have seen the thermometer indicate 100° to 110° Fahr. for days and weeks together, and no one complained of the heat as excessive, while all labor of man and beast went on as usual, and prostrations were unknown. I refer to the temperature in the shade. In the sun, where men work, it must be ten or fifteen degrees higher. In New York when summer heat approaches 90° we expect many prostrations and some deaths. I am not trying to show that 110° of heat in California with no prostrations is a better climate than New York at 90° with many prostrations, but to illustrate the principle that we must know much more about a climate than what the thermometer can tell us before we know very much about it. . . .

"Temperature may depend on latitude or on altitude; but it is not a matter of small moment which the cause may be. Sixty degrees of heat at the level of the sea and on the seashore are very unlike in physiological effect to sixty degrees in the dry and rarefied air of an elevated inland situation. There is no doubt that considerable moisture in the air favors the growth of minute organisms, and decomposition of matter takes place rapidly under the influence of heat and moisture. On the other hand, a dry air retards decomposition, and if sufficiently dry, prevents it entirely, no matter how hot it may be. The Sacramento Valley is very hot in the summer, but it is also dry, so that friends of mine would kill a beef and elevate the carcass by means of rope and pulley, to the top of a tall pole, let it down from time to time to cut from it, and it would keep perfectly sweet until it was all eaten up. A good illustration of conditions retarding or favoring the growth of minute organisms may be seen during the orange harvest in portions of California. The altitude of Redlands, California, averages about fifteen hundred feet above sea level. Fogs seldom reach there, the sun shines clear more than three hundred days of the year, and there is not a speck of mildew on any fruit. But go forty miles nearer the sea and seven or eight hundred feet down nearer the sea level; at every station you will see many people washing oranges; more fogs, denser air, less sunshine, more humidity favor fungous growths. On the high tablelands of the central portions of the continent, at an altitude of six or eight thousand feet, as in Wyoming, where a friend lives, milk does not 'sour' or change under a week or ten days, and the carcasses of dead cattle, of which there are many, give no offensive stench, but slowly dry up and waste away, showing that comparatively few organic germs exist there, and that the conditions for their rapid propagation are unfavorable.

"From the facts just stated — and they are representative facts — it would be too hasty to conclude that the higher and drier locality is essentially

more healthy than the lower and moister locality, even for consumptives, until we have mastered and estimated the quality and energy of the other meteorological influences. There is another fact which has come under my personal observation which must be taken into consideration. It is that life in those elevated, non-microbian regions is not without its drawbacks. Whether it is due to the increased action of the heart in the rarefied atmosphere, the constant hammering of the nerves by the winds and the fierce sunshine, or all these and other causes, people in those regions have a thin and tired look, and it is found useful and often necessary, especially in cases of women and children, to visit lower, damper, and more germ-laden regions in order to recuperate. It is important that the air we breathe should contain as few disease germs as possible; but it is still more important that we should breathe an air and live under such climatic conditions as shall most conduce to such general bodily vigor as will resist the entrance of disease germs into the organism, or destroy them if an entrance is once effected. . . . In these latter days, in the wonderful strides which have been made and are constantly being made in bacteriology, perhaps we are in some danger of losing sight of meteorology in its relations to health and disease. It seems to me that climatology has heretofore to a large extent resolved itself into a search for some place where consumptives cannot die. There is no such place. There is no place where the ever-present bacillus may not get in its deadly work. The chief question in climatology in its relation to health should be, In what climate, or by what changes and influences of different climates, can we be best invigorated for good existence in the location where we are obliged to live the greater portion of our lives?"

The Conditions of Atmospheric Humidity on the Sonnblick. — Dr. J. Hann has recently published a report on the Conditions of Atmospheric Humidity on the Summit of the Sonnblick, in which much interesting information is contained and many valuable results are presented. The records were obtained from a Richard self-registering hygrometer of improved construction, in which a bundle of hairs was used instead of a single hair. This instrument was adjusted and tested at the Meteorological Office in Vienna before it was set up on the Sonnblick, and great care was used to have the record as accurate as possible.

The yearly range of relative humidity on the higher mountain summits in the district in question is the reverse of what it is on the plains; the minimum, or greatest dryness, occurs in winter, and the maximum in spring and summer. This fact had been previously established by humidity records at other Alpine mountain stations, but all these records are somewhat unreliable, owing to the uncertainty of the behavior of the psychrometer at low temperatures. The difficulty of determining the exact humidity by means of the psychrometer when the wet bulb is covered with ice is very great, and the attention that the instrument should have under these conditions is not always to be expected from the observers on mountain summits, in the weather which prevails there. On the plains only the vapor pressure runs in a nearly parallel curve with the temperature, but on the mountain summits both relative and absolute humidity run nearly parallel with the tem-

perature through the year. Temperature and vapor pressure on the Sonnblick run in nearly parallel curves, and each degree C. of temperature change in the annual curve corresponds to a change of vapor pressure of 0.214 mm. in the same direction.

With the exception of the three winter months, we find in all the months a less relative humidity in the morning hours and a great humidity in the evening and night hours. The minimum of relative humidity comes between 7 and 10 A. M.; the maximum less regularly in the earlier or later evening or night hours. The diurnal range of relative humidity in winter is very different from that at the other seasons. From 6 to 7 A. M. the humidity is below the mean; from 9 A. M. to 5 P. M. it is above the mean. The highest relative humidity comes at noon and in the early afternoon; the lowest, in the early night hours. The greater dryness of the air during the night in winter is probably due to the descent of air, which is most effective at night because radiation during the night causes a downflow of air from the mountain sides into the valleys. In the afternoon, on the other hand, even in winter, the warming of the valleys may produce a cessation of the descent, or may even cause a reversal of this circulation, whence the relatively considerable increase of relative humidity in the early afternoon hours. The low relative humidity of the winter is to be explained by the prevailing tendency, at that season, towards a descent of air. In the summer, on the other hand, when the sun warms up the valleys from which the Sonnblick rises, the conditions are reversed.

The daily range of vapor pressure is nearly the same at all seasons of the year. The minimum occurs at 5 or 6 A. M.; the maximum in the early afternoon hours. The range of vapor pressure on mountain summits is not very different from that at low levels. In both cases the vapor pressure curve and the temperature curve run nearly parallel. In the case of relative humidity the conditions are different. On the mountain summits the relative humidity curve follows the temperature curve, although it is somewhat behind the latter, while at low levels the reverse holds true, the relative humidity falling when the temperature rises. The daily range of vapor pressure on mountains seems to be the same everywhere. The minimum comes in the early morning hours, the same as at lower levels; the maximum comes between 2 and 4 P. M., earlier than at low levels. On mountains the rising temperature and the ascent of the air work together to produce an increase in the amount of water vapor in the afternoon hours. On plains, however, the ascending air carries away a portion of the additional water vapor which the rising temperature has produced, and the vapor pressure cannot increase; in fact, it may even show a slight decrease at the warmest time of day. Towards evening, when the interchange of air between the lower and upper strata ceases gradually, the amount of vapor in the lower air increases and locally attains an absolute maximum.

At low levels the greatest relative humidity comes in the early morning, the least in the afternoon, at the warmest time of day. The causes of the differences in the humidity curves below and aloft are clear. The ascending valley winds carry, towards evening, a great degree of humidity to the upper heights, as is well known, and clouds may be formed in consequence. The

result of this is that the maximum of relative humidity occurs on mountain summits in the evening hours, at the time of increasing cloud formation.

The most noticeable feature in the daily range of re'ative humidity is that on clear and very warm days, long before the sun has any effect, the relative humidity on the Sonnblick falls below the mean, and by 6 A. M., when the sun can hardly have warmed the mountain or the thermometer shelter at all, the relative humidity is almost 7 per cent below the daily mean. From this fact it would appear that the relative dryness of the air on mountain tops in the forenoon cannot be explained as chiefly due to a warming of the mountain, but to a descending movement of the air, caused by the mountain winds blowing towards the valleys, these winds being themselves due to the nocturnal cooling of the mountain sides.

One of the most marked phenomena in the curves of relative humidity on the Sonnblick is the frequent and sudden occurrence of periods of great dryness, which are common in winter. These dry periods occur with high pressure and are associated with a rise of temperature, the wind usually having a northerly direction, and a considerable velocity. It is to be noted that the wind often increases in strength at the time of the beginning of one of these dry periods, and that it is probably not so much a change in direction of the wind as a downward component which brings the dryness; the beginning of these periods may occur at any time of day. The relative humidity falls very rapidly at first; then more slowly, with an average change of 47 per cent in five hours. The pressure and the temperature rise at the same time. The relative humidity does not fall simply in consequence of the increasing temperature, but the absolute humidity decreases at the same time. In other words, air with less water vapor has been brought in. There is hardly a doubt that this drier air comes from greater heights.

The Audibility of Fog Signals. — The following is taken from a Report upon Fog Signal Experiments, by Major William R. Livermore, Corps of Engineers, U. S. A., reprinted on the *Pilot Chart of the North Atlantic Ocean*, for July, 1895: —

"The sound reaches the ear through the air, and the chief causes of irregularity are found in the varying velocity and temperature of its currents, causing the sound wave to be reflected or refracted. It has been repeatedly stated, and confirmed by sufficient observations, that fog, rain, snow, etc., do not of themselves obstruct the passage of sound. They may tend to increase or diminish its intensity, according as they affect the temperature or velocity of the air.

"When sound passes suddenly from hot to cold air, or from cold to hot air, it loses some of its intensity, and if it passes through a number of such changes it may be wholly lost in regions where it would otherwise be heard.

"Sound is generally transmitted better in cold than in warm air, because it is more homogeneous; for the same reason it is generally transmitted better through a fog, because when the air is near the point of saturation a slight change in temperature might cause so much evaporation or condensation as to reduce its range by one half. Snow falling through the air acts in a similar way to check the minute currents and eddies. Sound

travels a little more rapidly in hot than in cold air; in wet than in dry air; a little more rapidly with the wind than against it.

"The audibility of a fog signal depends not only upon the instrument that generates the sound and the influences that affect the transmission to the region where it is observed, but also upon the position of the observer and the disturbing influences that affect his hearing. Too little attention is generally paid to these circumstances. For example, a light-keeper reported that he could hear the sound of a fog signal, located about 10 miles southwest of his own station, much better in a wind from the northeast than in one from the southwest. On questioning him closer it appeared that with a southwest wind the surf at his station drowned all other sounds, whereas in a northeast wind, the sea was calm, and he himself was completely sheltered by the buildings at his station. Another keeper had noticed the same phenomenon at his station; he could not hear the distant signal from the lighthouse, but could hear it at his boathouse farther back in quiet water. As another instance, our own observers once noted that a signal was repeatedly heard much farther in running away from it than in approaching it. An analysis of the observations showed that in the former case, the vessel was running with a strong wind, and in the latter against it.

"It has often been observed that a fog signal can be heard better at the masthead than on the deck of a vessel. This may be due to several causes; where the sound ray is so tilted up as to make the signal inaudible on deck at less than 1000 yards' distance it has been noted that the audibility perceptible increased in going aloft. On the other hand, at a distance of several miles, the effect of a few feet in elevation is comparatively insignificant; whereas, the observer at the masthead is farther removed from the splashing of the waves or the sound of the engine.

"Mariners differ so widely in capacity that rules which would be very useful to one might be misleading to another. No definite instructions can be prepared that will insure against accidents. Even the best of seamen are often harassed by cares and duties that divert their attention for the moment, and in case of disaster the most conflicting accounts have been given of the aberrations of the audibility of fog signals. The noises upon the ship, the noise of the wind and waves, and the condition of the nerves, all affect the audibility of fog signals to a degree that can best be appreciated by studying the evidence. It is impossible to navigate in bad weather without more or less risk. Mariners should study the principles that affect the audibility of fog signals, just as they study the art of navigation, and should notice the wind and temperature whenever they hear fog signals. They should only depend upon hearing them at short range, unless the wind and weather favor the sound, but if they do hear them at long range they should make what use they can of them.

"They should remember that it does not require a very heavy wind to drive back the sound; that a southerly wind generally drives back the sound more than a northerly or an easterly one; that about the time of a change in the wind the sound is not generally heard as far as usual; that when the upper and lower currents of air run in different directions, or when the upper sails fill and the lower sails flap, or conversely, the signal is not

to be depended upon; that a very heavy wind tends to break up all sound; that if a vessel is travelling with the wind the signal will probably be heard better than if it were travelling against it; that behind a hill or an island the signal may be heard better at a distance than nearer the obstacle; they should bear in mind that it is hard to locate a feeble sound, and even a strong one may appear to come from the wrong direction if it is obstructed by objects near it, even by objects not directly in the straight line between the observer and the signal; that neighboring cliffs and sails sometimes reflect the sound; that the sound may be cut off entirely by passing vessels; that to estimate the direction of the sound the head should be turned rapidly from side to side, so that the sound may reach the ears alternately."

*Sunshine in California.** — The Weather Bureau makes record of all meteorologic phenomena, among which is the record of the number of hours and minutes each day that the sun shone. This record is made by a photographic process or by an electrical register; each possesses merit, and both give very accurate results. Records of sunshine have been made at San Francisco since April, 1890, and a record has also been made at San Diego. At other Weather Bureau offices in California, no sunshine record has been made. However as a record of the clear, partly cloudy, and cloudy days has been made at all stations in California as elsewhere, the approximate amount of sunshine can be ascertained for all places in California in conjunction with the absolute sunshine record now made. This paper is for the purpose of disseminating such information concerning the record of sunshine in California as the Weather Bureau has so far collated. The rays of the sun are the life-giving properties to all living things. The existence of ourselves, our health, the germination, growth, and development of all vegetation is dependent on sunshine. The presence or absence of sunshine regulates, to a very great degree, the condition of the invalid and controls the actions of the healthy. Especially is the sunshine of value to the people of California in their vineyards and fruit drying. It is true that an excess of sunshine makes a country arid, a deficiency makes a country humid, but favored, indeed, is the country of a medium between these extremes. The records of San Francisco show that it enjoys, on an average, 58 per cent of the possible sunshine; that the month of June has the greatest amount of sunshine when the per centum of the possible amount is 70, and that December has the least with 43 per centum. The amount of sunshine at San Francisco in December, 43 per cent, is however 1 per cent more than the average amount of sunshine that occurred at Cleveland, Ohio, during the year of 1893. The average amount of sunshine at San Francisco in the various months of the year, based on the past five years' record is, in per cent. of the possible: January, 52; February, 52; March, 52; April, 63; May, 59; June, 70; July, 69; August, 57; September, 61; October, 64; November, 57; December, 43.

The average annual being 58, it is seen that from April to November, inclusive, there is more than the average sunshine, and less than the average

* Issued by Mr. B. S. Pague, Local Forecast Official, San Francisco, Cal., July 20, 1895.

from December to March, inclusive; these latter months are practically the months of the rainy season, yet the average sunshine for these rainy months is 50 per cent, and this average is more than the average annual sunshine over the New England and Middle States and over Kentucky, Ohio Indiana, and the region of the Great Lakes, or more in San Francisco during the period of least sunshine than prevails on an average throughout the year over that portion of the United States where the population is the densest. It should be remembered that San Francisco is on the immediate coast, and that naturally more cloudy or foggy weather will there prevail than at places farther removed, hence a greater amount of sunshine prevails in the interior.

At San Diego there was 68 per cent of the possible sunshine during 1893, figures taken from the latest report of the Chief of Weather Bureau. This report shows that August had 76 per cent of possible sunshine; April and October, 75 per cent; July, 73 per cent; November, 71 per cent; February, 70 per cent; September, 69 per cent; January, May, and December, 66 per cent; June, 61 per cent, and March, 56 per cent, or that at San Diego, the least amount of sunshine in any month is in March, when 56 per cent of the possible prevails; and this is a larger amount of sunshine than the average annual amount which prevails over all that portion of the United States east of the Mississippi River and north of a line drawn on the latitude of Omaha. On an average throughout the year, 80 per centum or more of the possible sunshine prevails at San Diego from 11 A. M. to 5 P. M. At San Francisco from 70 to 78 per cent of the possible sunshine prevails from 11 A. M. to 5 P. M. It is to be regretted that there are no absolute sunshine records at Red Bluff, Sacramento, Fresno, and Los Angeles; however, considering the number of clear and partly cloudy days at the various places, the approximate sunshine for each place is obtainable, and hence it can safely be assumed that at Los Angeles the per cent of possible sunshine is 70; at Fresno, 66 per cent; at Red Bluff, 65 per cent; at Sacramento, 60 per cent; and at Keeler, 64 per cent. The sunshine at Los Angeles, 70 per cent, is the greatest in the United States save over Arizona, New Mexico, southern Kansas, and contiguous sections, where it amounts to from 74 to 77 per cent of the possible, the greatest amount being at Tucson where it amounts to 77 per cent.

The Frost of January and February over the British Isles. — Messrs. F. C. Bayard, F. R. Met. Soc., and William Marriott, F. R. Met. Soc., have a paper on "The Frost of January and February, 1895, over the British Isles" in the "Quarterly Journal of the Royal Meteorological Society" for July, 1895 (pages 141-158). This paper has already been summarized in this JOURNAL (for July, 1895, page 99) but the following additional quotations are here added, as being of special interest: —

"The effect of the cold on the public health was very great, especially on young children and old people. The total number of deaths in London was below the average till the week ending Feb. 2, after which they rose with great rapidity until March 9, when the registered number of deaths for that week was 3,471, or 1,583 above the average, the death rate being 41.2 per thousand. After this the number of deaths rapidly decreased, and by

March 30 had almost fallen to the average. . . . There was comparatively little effect of the cold on people in vigorous health, that is between 5 and 40 years of age. The effect on middle-aged people — that is between 40 and 60 — was very pronounced, the deaths rising from 324 on Feb. 2, to 669 on March 9. Children under 5 years of age suffered severely, the deaths rising from 462 on Jan. 26, to 1,013 on March 9. The effect of the cold on old people — that is above 60 years of age — was most remarkable, the number of deaths rising from 437 on Feb. 2, to 1,331 on March 2, and 1,368 on March 9, being an increase of more than three times the number in four weeks. . . .

"The intense cold caused great destruction in animal and vegetable life. Rabbits, hares, and game especially suffered, large numbers being frozen, and the remainder being in a great measure only kept alive by artificial food on the moors and fields, and in the farm yards. Deer left the forests in Scotland, and came in herds to the different farm yards, and to the numerous trains which were embedded in the snow, for warmth and food."

Height of the Sea-Breeze at Toulon. — According to the "Quarterly Journal of the Royal Meteorological Society," for July, 1895, page 183, two interesting balloon voyages were made at Toulon on Oct. 16 and 18, 1893. On Oct. 16, MM. Louis Godard and Jacques Courty ascended from Toulon at 11.20 A. M., and were carried by a south-southwest wind towards Fort Faron. But at a height of about 1,600 feet the balloon began to turn towards the south, and at a height of 3,450 feet its course was due south. After passing the coast at an elevation of 4,690 feet, it was carried by a northeasterly wind over the roadstead and the peninsula of Cepet. The aeronauts then descended, and found a southwesterly wind at an altitude of 1,000 feet. On the second voyage the ascent was made at 4.20 P. M., and an easterly current was found up to a height of 1,300 feet. At 2,000 feet the balloon was suddenly driven southwards towards the sea, and on descending to 520 feet entered the easterly current again.

From these measurements it appears that the height of the land and sea breeze circulation is, at most, 3,000 feet. This limit is subject to changes controlled by the transition from day to night. On Oct. 16 and 18 Toulon was at the southeastern edge of an area of maximum pressure, with a fairly uniform pressure and light easterly winds in the neighborhood.

Second Annual Report of the North Dakota Weather Service. — The Second Annual Report of the North Dakota Weather Service, for 1894, has been issued by Mr. B. H. Bronson, the director. The service now has forty-two observers, eighteen forecast display men, and thirteen frost warning display stations. The mean annual temperature for 1894 was 40°, an excess over the mean of 1°. The normal precipitation for the State is 17.23 inches, the precipitation for 1894 being 16.10 inches, which gives a deficiency of 1.13 inches. The highest temperature recorded during the year was 107° and the lowest, 47°. The monthly bulletin and the weekly crop report are more and more appreciated, and the demand for them is steadily increasing.

CORRESPONDENCE.

THE JUNE RISE OF THE MISSISSIPPI.

Editor of the American Meteorological Journal:

Every year in June there is more or less rise of the waters of the Mississippi River above its confluence with the Missouri River. The old explanation of this rise current in this section has been, that the rise of the water is due to the melting of the snow and ice in the upper courses of the Mississippi. The distance of this portion of the Mississippi from its head streams is nearly five hundred miles. The known rate of flow of the waters of this river is about five miles per hour, which would make about one hundred miles for each twenty-four hours, so that the whole distance would be traversed in less than one week. As the snows melt off during March and April, it can be seen that the "June rise" cannot be due to the melting of the snows.

The Ohio River has its highest flow during March and April at Cairo, Ill. The Mississippi, at Vicksburg, has its highest flow during May. The Missouri River has its highest flow between Sioux City and Kansas City during the latter part of June, and the Ohio, at Pittsburg, has its highest flow from February to April. These mark the melting of the snows.

The great northwest prairie country has its heaviest rainfalls for the year during the months of May and June, and it is to this heavy rainfall that the June rise, of both the Missouri and Mississippi rivers, is due. An absence of a marked June rise betokens an absence, which sometimes occurs, of this heavy rainfall in the northwest country, and it bespeaks an absence of its usual bountiful crops.

E. J. COUCH.

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BIBLIOGRAPHICAL NOTES.

THE CULTIVATION OF THE OLIVE IN TEXAS.

JOSEPH L. CLINE, B. S. *The Climate of Texas in its Relation to the Cultivation of the Olive.* Texas Weather Service. Special Bulletin, No. 6. Issued in Co-operation with the Galveston Cotton Exchange. 8vo. Galveston, 1895. Pp. 7.

The sixth Bulletin in the series issued by the Texas Weather Service in co-operation with the Galveston Cotton Exchange is on "The Climate of Texas in its Relation to the Cultivation of the Olive," was prepared by Mr. Joseph L. Cline, of the U. S. Weather Bureau at Galveston, and was read at the annual meeting of the Texas State Horticultural Society, at Bowie, Texas, July 31, 1895. The Texas Weather Service is certainly to be congratulated on the valuable work it is doing in issuing these Special Bulletins, which give so much useful information regarding the climate and the crop production of the State. Indeed, we know of no other State Weather Service which is publishing so much of distinct value, both to its own people and to outsiders, as the Texas Service. It is altogether too much the custom to issue only the regular meteorological data from month to month, without any general deductions as to climate and crops. Of course, in many of the States the body of material is as yet too small to warrant its being used as the basis of climatic studies, but we hope that the example set by Texas may soon be followed by other State Weather Services.

Mr. Cline, in his paper, gives a general climatic account of his State, including special consideration of frosts and winds, and then goes on to consider the question of the cultivation of the olive. The olive tree has been known to stand temperatures as low as 14° Fahr., and still to bear that year; and it is believed that the hardier trees will endure even lower temperatures than this and produce fruit, especially if the cold weather be dry. When injured by cold the roots and body of the trees are not affected, and if the trunk is properly pruned sprouts or twigs will grow and bear fruit when two years old. The olive needs a sandy soil, well drained. It accustoms itself to dry and wet climates, but clay and mud are unfavorable to it. In certain portions of California it is grown without irrigation, and the rainfall there is less than over western Texas. It is reported that on the foothills of Santa Barbara County and around San Jose, California, the frequent fogs yield sufficient surface moisture for the olive.

As the result of a careful study of the subject, Mr. Cline concludes as follows: "I am convinced that the olive will thrive in Texas as far north as the thirtieth and possibly to the thirty-first parallel of latitude, and it is

believed that in the course of a few years the cultivation of the olive will be one of the leading industries carried on over the southern portions of the State. However, I consider the cultivation of this fruit in southern Texas of interest to the horticulturists of the northern part of the State, for that which is beneficial to the people of part of the State will in time be of benefit to those of the other part. In fact, if the horticulturists of the southern portion of the State can cultivate a fruit which cannot be grown in the northern portion, they can afford to do so. Then those of the northern portion can cultivate a fruit which is not grown in the southern portion, and by this method all will be benefited alike and will not affect the market of each other's products, and hence will obtain a better price for their fruits."

REPORT OF THE INTERNATIONAL METEOROLOGICAL COMMITTEE.

Report of the International Meteorological Committee. Upsala, 1894. Published by authority of the Meteorological Council. Official, No. 115. 8vo. London, 1895. Pp. 48. Price, one shilling.

The report of the Upsala meeting of the International Meteorological Committee has recently been issued under the supervision of Mr. Robert H. Scott, F. R. S., the Secretary of the Committee. It contains the minutes of the five meetings of the Committee, and in the Appendices presents the following matters: I. Report of the Secretary. II. Remarks on the Proposed International Meteorological Bureau (H. Hildebrand Hildebrandsson). III. Proposal relating to the more Rapid Transmission of Meteorological Telegrams (G. Neumayer and M. Snellen). IV. Tele-meteorography (Dr. van Bebber). V. Tele-meteorography (M. Snellen). VI. Note relative to the Scintillation of Stars (C. Dufour). VII. Congress of Atmospheric Science, Antwerp, 1894. VIII. Report of the Committee on the Cloud Atlas. IX. List of Countries in which Cirrus Observations will probably be taken. X. Proposal for Simplifying the Taking of Simultaneous Photographs of Clouds (A. Sprung). XI. Circular as to Communication of Meteorological Information to Agriculturists, and Replies.

In this JOURNAL for December, 1894, we published an account of the Upsala meeting by Mr. A. Lawrence Rotch, who was at Upsala as a member of the Cloud Committee, and therefore any further account of the proceedings is unnecessary at the present time.